



## Small Business Innovations

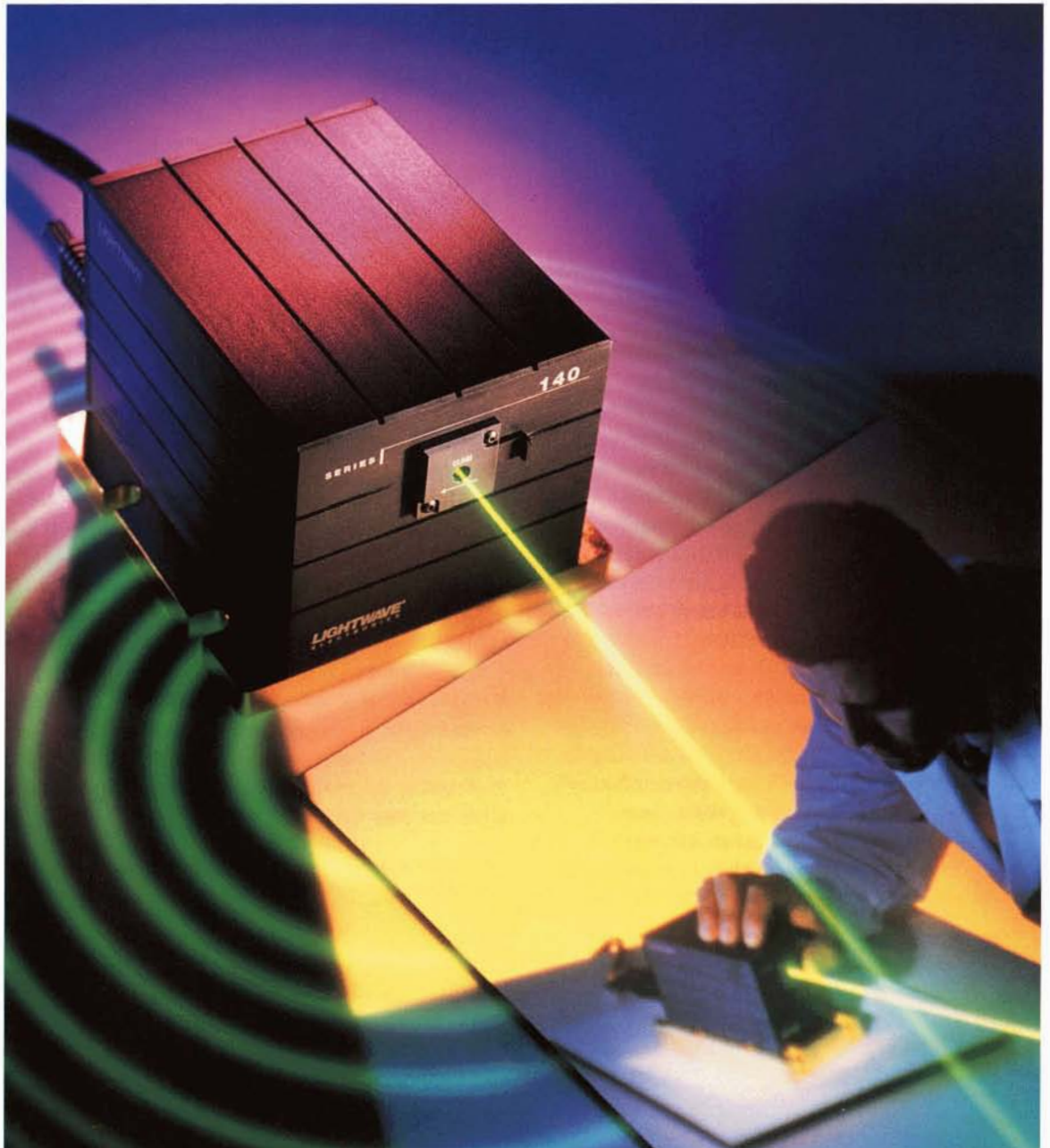
Industrial Productivity and Manufacturing Technology

Shown **below** is a Series 140 single frequency laser produced by Lightwave Electronics Corporation, Mountain View, California. It is a new member of a family of laser systems based on technology originally developed under a NASA Small Business Innovation Research (SBIR) contract.

The original contract with Jet Propulsion Laboratory called for development of a prototype laser-diode-pumped solid state transmitter. Lightwave delivered a low noise ring laser with wavelength tuning that could be used as a

local oscillator in an optical communications network. The wavelength tuning feature allows "phase locking" two lasers, generating electronic frequencies, in the manner of radio and microwave electronic oscillators.

From this technology, Lightwave developed the commercial Series 120/122, Series 123 and the Series 140 lasers, which have applications in fiber optic communications, difference frequency generation, fiber optic sensing and general laboratory use. They feature a patented resonator design known as NPRO (nonplanar ring oscillator).







The combination of NPRO and laser diode pumping, says Lightwave, offers "greater reliability, smaller size and superior performance compared to conventional lamp-pumped products."

Established by Congress in 1982, the SBIR program is designed to increase small business participation in federal high technology R&D activities and to stimulate conversion of government-funded research into commercial application; it has generated spinoff applications in about one of every three projects approved for funding from proposals submitted by small businesses.

A second example of an SBIR spinoff is the Phase Doppler Particle Analyzer (PDPA) developed by Aerometrics, Inc., Sunnyvale, California as an offshoot to an SBIR contract with Lewis Research Center. The PDPA, shown **above** conducting a spray characterization test, is a non-disruptive, highly accurate laser-based method of determining particle size, number density, trajectory, turbulence and other information about particles passing through a measurement probe volume. The system consists of an optical transmitter and receiver, a signal processor and a computer with software for data acquisition and analysis.

Velocity and size data are inferred from particles that are carried within the flow field being studied. Velocity profiles are obtained by analyzing the Doppler difference frequency of light scattered by particles passing through the intersection of two laser beams. Particle diameter is determined by measuring the phase difference between three detectors positioned a known distance from each other.

Aerometrics offers a variety of PDPA systems for different applications. A major application is spray characterization for various sprays and spray generators, such as paint, agricultural, fire sprinkler and fuel sprays; electrohydrodynamic flows; atomizers and spray nozzles. The PDPA also has utility in combustion, aerodynamic and underwater research studies.



A related product stemming from the same SBIR work is Aerometrics' Microsizer (**above**), an adaptation of PDPA technology for medical equipment manufacturing and analysis of small sprays, nebulizers, aerosols, mists and other contained flows. Developed for a customer producing metered dose inhalers (MDIs), the Microsizer provides discrimination between propellant and medicine by determining the size of particles emitted and their concentrations, information important to quality assurance.

A third example of SBIR commercialization is the work of Millitech Corporation, South Deerfield, Massachusetts. Millitech specializes in high frequency components and subsystems operating in the upper portion of the millimeter wave (MMW) frequency range, from 30 to 700 gigahertz; this is an area where the commercial state of the art is limited and Millitech has focused on this area to carve a business niche by developing a broad line of high performance, readily-available products.

Millitech has conducted a number of NASA SBIR projects, principally with Jet Propulsion Laboratory, and this work has generated several commercial MMW products; a sampling is shown **at right**. Millitech considers its most important contributions to be in quasi-optical components and active components. In particular, the company has advanced the state of the art in sensitive receiver technology by developing very high performance mixers and multipliers.

Although the principal market is the scientific research community, Millitech high frequency components are finding practical applications beyond laboratory use. They are generally used in receivers and transceivers for such applications as monitoring chlorine monoxide, ozone, water vapor and other atmospheric compounds; in radioastronomy; in plasma characterization; and in material properties characterization.

